MODERN MILLING.

GRIMSHAW.

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MODERN MILLING.

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MEMBER OF THE FRANKLIN INSTITUTE, OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, AMERICAN INSTITUTE OF MINING ENGINEERS, THE FRENCH *SOCIÉTÉ DES INGÉNIEURS CIVILS*, &c., &c., &c.

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PREFACE.

The following extempore addresses were delivered at the solicitation of Eastern millers and others, and with the intention to outline in clear and popular form, the changes that are taking place in the great and growing flouring industry, to which this country already owes so much. They are here published from the phonographic reports, substantially as delivered; merely excising some repetitions and purely local or ephemeral remarks, and adding a few foot notes, &c.

They seemed appreciated at the time of their delivery, and it is to be hoped that they may interest and in some measure instruct many before whom the author had not the pleasure of appearing in person, on the occasions of their delivery.

PHILADELPHIA, JUNE, 1881.

5468

MODERN MILLING.

I HAVE chosen as the subject of my remarks "Modern Milling," rather than the title "New Process Milling," which has been advertised,—because "Modern Milling" covers a wider field than the words "New Process," which have often been applied, but which are a misnomer.

"New Process," as a trade term, is strictly a definition of one of the many new processes, or new systems, which constitute modern milling.*

The advance of milling, within the last decade, has been a great stride,—as great a stride as from the time when that prince of millwrights, Oliver Evans, lying upon his back and looking up at the dusty beams of the Brandywine Mills, studied out the elevator, the hopper boy, and the spiral conveyor; and almost as great a stride as from the early days of the quern, or rough stone, used for bruising the grain in the hands, up to Oliver Evans' date.†

* Just as to how many "processes" there are in modern milling, or where the dividing lines between them are, is by no means settled—some recognizing only two, others a dozen or more.

† 1795 is the date of his book on milling.

While there are many things in modern milling which were suggested or invented, or even actually practiced experimentally, hundreds of years ago, yet within the last ten years, and especially in America, the changes which have been wrought have completely revolutionized the business. These changes have been radical and searching; there have been changes in the apparatus employed; in the mode of dressing and handling the apparatus; in the material converted, and in its preparation; in the processes employed in converting the material; in the product of the new apparatus, materials and processes; in the location of the industry; in the customs of the trade; in the size of the mills; in the motive power employed in its transmission; in the market for the new products; in the importance of the industry—changes so radical, so complete, as to have transformed the old art or rule of thumb into a complicated but exact science, worthy of the most intelligent study of modern genius.

While we may divide the art of milling into two great methods, high and low grinding, these changes which have taken place have so pervaded every operation in milling that there may be blocked out five or more separate systems or processes in the grinding or granulation alone; each of these following some changes and preceding others, so that the various processes so delicately shade off one into the other, that it is difficult to classify them. When we divide the art of milling into five or more processes, we may divide them with reference more particularly to the mode of grind-

ing or granulation, which is the principal operation in milling.

Grinding or granulation may be effected by any one of four or more great classes of machinery.

First, flat cylindrical millstones built up of blocks of buhr-stone—a hard, porous silicious rock occurring in nodules in a very few quarries. These may have either the upper or under stone the runner; or may be set vertically. In any of these three cases either the runner or the bed, or both, may be either rigidly attached to the axis, or oscillating.

The second class consists of rough or corrugated iron disks or cones.*

The third, which has grown so rapidly in importance, includes rollers, which may be of biscuit (miscalled porcelain), stone, corrugated or smooth iron, or steel; and whatever the material employed for the rolls they may be used either singly, working against a concave, or in pairs; they may have motion either in the same or in different directions, and at either equal or differential speeds.

The fourth class of granulating machinery includes those operating by percussion or attrition.†

A fifth class, perhaps only a variation of the first, and not yet in practical operation, consists of granulating disks composed of glass blocks or of porous blocks of biscuit ware, and intended to replace buhr-stone as a material for millstones.

* Iron disk milling bids fair at present to develop into a formidable claimant for public recognition.

† Not in practical operation in this country, unless perhaps in one or two small mills.

Cutting rolls are also employed, as well as compressed air to blow the berries to powder.*

Employing any one of these classes of machines or any combination of them, we may grind either "high" or "low," or by "gradual reduction"—that is, 1 we may aim to make as much flour as possible at one grinding from the wheat; (2) we may try to produce at one operation very small but sharp granular pieces of the berry which shall subsequently be ground into flour; or (3) we may endeavor to produce granular pieces with several gradual reductions, and to produce the highest grade and the greatest quantity of flour from these.

The first system is called low milling, the second high milling, and the third, gradual reduction.† Of course so many subdivisions of such a complicated work could not be thoroughly or even superficially brought out in the course of two evenings' remarks. We shall, then, confine ourselves more particularly to the consideration of two subdivisions. (1) High milling with buhr millstones; that is, buhr middlings milling; and (2) high milling with rollers; that is, roller middlings milling.

It shall be my endeavor to block out for you an outline of the many operations in each of these methods of milling, which in most respects (outside of granulation, in which they radically differ) lie parallel.

I shall first rehearse in greater detail the changes

* More of a scientific toy than a working success.

† Hardly any two authorities agree as to where the dividing lines exist.

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which have taken place in milling, not merely since the day of Oliver Evans, but in the last ten years. First, in the material. Formerly the hard spring wheat which is the output of our north-western territories and cold climates was difficult to handle, not so much by reason of its hardness, as because of the extreme thinness and brittleness of its bran. Now, this hard spring wheat is by preference employed, not only because the new granulating devices handle it better than those of old, but because new machines have sprung up rendering the miller largely independent of any condition of the bran upon the berry. In order that we may more distinctly comprehend the operation through which the berry of wheat passes, it will perhaps be best to show upon the screen views of the berry itself magnified.

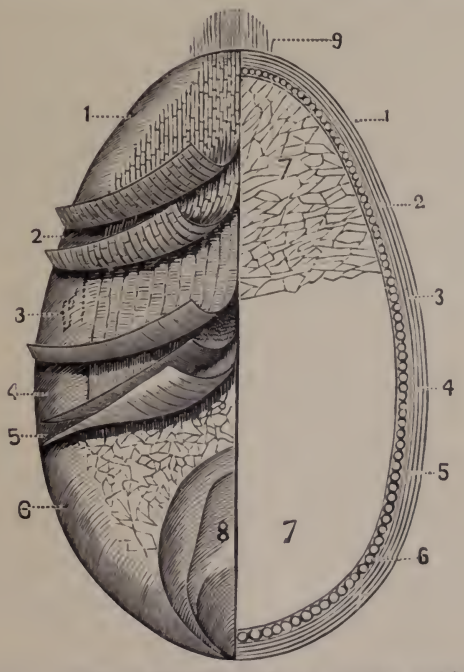

FIG. 1.—LENGTHWISE SECTION OF WHEAT BERRY

As you will notice, the diagram (Fig. 1) shows an imaginary section of a grain of wheat magnified* to about three feet in length. You will note that its outer envelope consists of five layers, marked 1, 2, 3, 4, and 5; these layers, being thin, scaly, and fibrous, and constituting a woody envelope or bark, commonly called the bran; a material not only valueless to the miller, but extremely troublesome by reason of its tendency to mix with the more valuable portions and to remain there, adulterating and diluting it.

Within this outer coating of bran comes a layer containing the most valuable part of the berry, and which unfortunately lies next to and almost adhering to the worthless bran. This layer consists of cells of gluten, a substance containing a higher percentage of nutriment than the rest of the berry, and giving to the flour its strength and its rising properties. The more gluten the flour contains, the "stronger" it is, that is, the more dough can be made from a barrel of it; the better the dough will rise, and the more nourishing the bread will be. Within the layer of gluten cells lie the albuminous starch granules which constitute the greater bulk of the berry.

At the bottom of the illustration you will see the germ or embryo, a yellowish, oily body, not desirable as a constituent of the flour—largely by reason of its discoloring properties.

At the top of the illustration you will see the "fuzz" or beard of fine woody fibres; innutrious, discoloring, and undesirable.

* By the oxycalcium projecting lantern.

Snugly tucked away in the crease of the berry, is a certain amount of bluish "crease dirt," difficult to remove, and extremely retentive of its place in the flour; and of course discoloring in its properties.

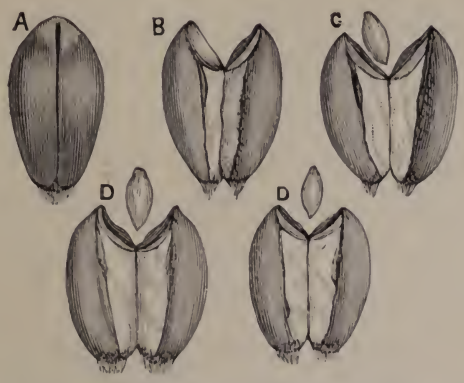

FIG. 2.—IDEAL SPLITTING OF WHEAT BERRY IN GRADUAL REDUCTION.

The next diagram (Fig. 2) shows a whole berry, and a few berries just cracked lengthwise as by ideal milling, to liberate the germ.*

Lying upon and adhering to the outer coating of bran, as well as partly in the crease, there is a certain amount of loose dust, innutritious and discoloring.

There is also in any large bulk of wheat a varying proportion of mechanically mixed impurities, such as oats, chaff, chess, cockle, sticks, stones, straws, garlic, grass seed, sand, gravel, rat dirt, rivets, iron wire, miscellaneous fragments of metal, &c.

In Pennsylvania and in neighboring sections there is great trouble from garlic seeds, which not only have a strong odor and spoil the flour, but contain a gummy

* Figs. 1 and 2 are given by courtesy of Messrs. Chisholm Bros., Chicago.

substance which fills up the pores of the stone and glazes their faces, so that they have to be washed every few hours.

Now, the great problem of the miller is to remove all the mechanical impurities, all the innutritious and discoloring portions of the berry, and to avail himself of the albuminous starch granules, and of the gluten cells, especially of the latter.

It is not an easy problem to solve, and it should be a source of great wonder that its solution has been so satisfactory, not only from a technical point of view, but as a commercial success.

In the preparation of the wheat, the changes that have taken place lie in its much more thorough handling and cleaning, and in the toughening of the bran. The old operations are more thoroughly performed, and are supplemented by new ones.

The object of cleaning is fourfold:—

First.—To extract from the wheat as thoroughly as possible all the dust, dirt, clay, stones, and foreign substances which would tend to impair the quality of the flour, together with the beard and crease dirt in the berry itself.

Second.—To extract any light, shrivelled or soft berries that are among the sound ones.

Third.—To remove any grass seed, garlic, cockle, oats, and other seeds, clean or otherwise, that it may contain.

Fourth.—To insure that it is perfectly dry.

Before grinding, the wheat, if it be at all wet from having come in leaky canal boats, or from other such causes, is thoroughly dried to prepare it for the subsequent operations. It then passes through what is known as the separator, the object of which is to remove by sieves and by currents of air all the lighter mechanically mixed impurities; the sticks, straws, chaff, chess, oats, &c. Good wheat should not have a half a pound of dirt to the bushel.

Two forms of separators are shown in Figs. 3 and 4.

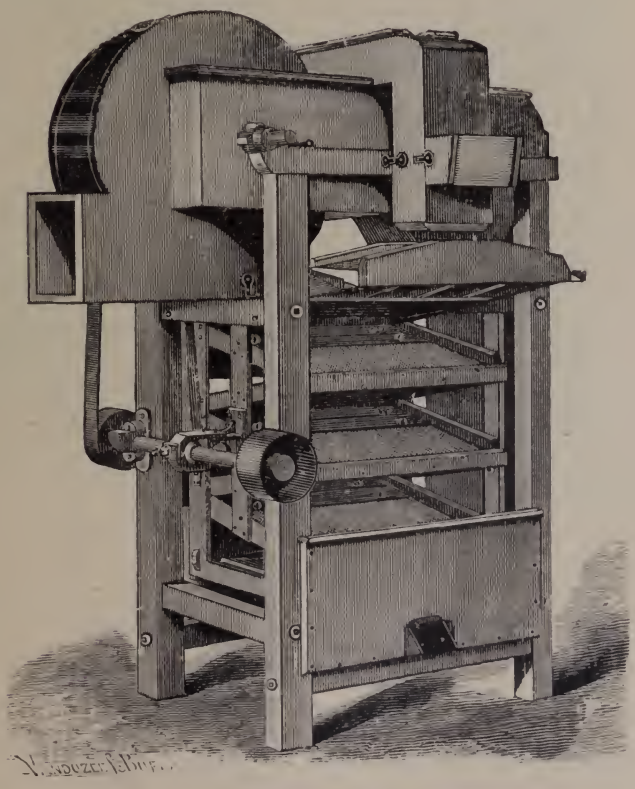

FIG. 3.—SEPARATOR.

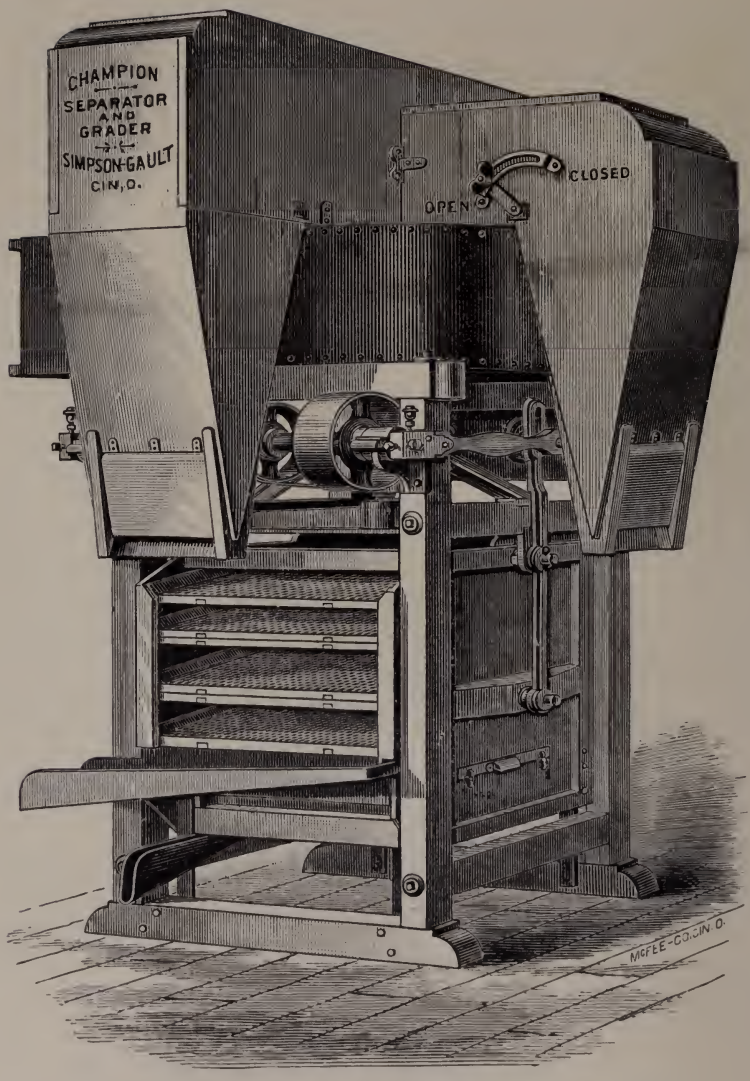

FIG. 4.—SEPARATOR.

It then passes through the "smutter" or "scourer," shown in the illustrations (Figs. 5 and 6). The object of this is to break up the smut-balls and to remove the less tightly adhering particles of dirt from the outer part of the berry. As you will see by the illustrations,

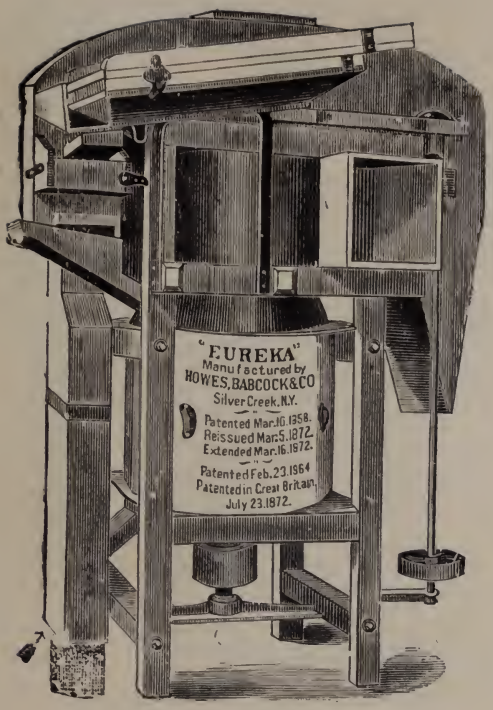

FIG. 5.—SMUTTER.

it consists of an upright drum revolving in a case of perforated metal. Between this revolving drum and the perforated case the wheat falls; the rapidly revolving drum breaking up the smut-balls and effecting a thorough scouring of the wheat berries among and against the beaters and the walls of the perforated case.

A current of air drawn in from below by the fan above carries this dirt through the perforations in the case into a surrounding jacket, and out of the building.

It is desirable to effect as thorough a cleaning as possible without breaking the berries, after being graded in size.

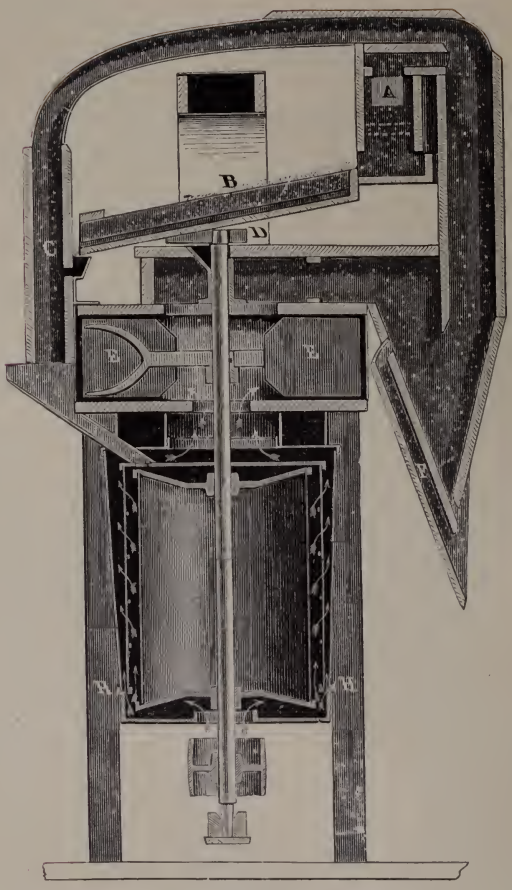

FIG. 6.—SECTION OF SMUTTER.

In some mills the fuzz or beard is removed by causing the grain to pass in a perpendicular position between large rotating sandstone disks called "ending stones."*

While the scourer effects a most satisfactory change for the better in the appearance of the berry, it does not remove all mechanically adhering dirt.

* There is hardly any one subject upon which millers differ so radically, and dispute so rabidly, as this one question of ending stones. I may say, however, that I do not know of any of our mammoth North-western mills that use them.

That in the crease seems as yet indislodgeable (if there be such a word—and if there is not, I shall make it to order and use it while new.)

To attack this (the crease dirt, not the word) the brushing machine is employed. It is similar to the smutter, save that the drum consists of a cylindrical tampico brush revolving in close contact with the case. This brush gets at the crease dirt and largely removes it, besides which it polishes the bran coating, so that the once dull, lifeless wheat, intermixed with all kinds of filth and other impurities, emerges with a bright and smiling face.

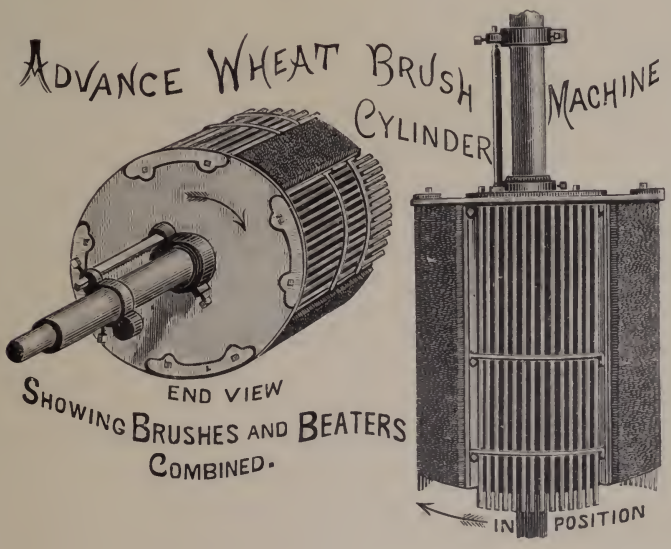

FIG. 7.

The cut (Fig. 7) shows the cylinder of a combined smutter and brush machine, removed from the case. Almost any cleaner that breaks wheat causes a waste.

The wheat cleaning machine should be placed so that

it can be easily reached and carefully looked after by the miller.*

There is no use in saying that wheat can not be cleaned so that there shall be no fuzz on the end of the grain, because this not only can be done, but is done every day in many mills. The fact that it is not done in nine mills out of ten shows that there is room for improvement there.

Among the changes that have taken place in the preparation of the grain may be mentioned one which is dependent upon or caused by the change in the mode of harvesting.

With the introduction of the wire-binding reaper came a new trouble to millers; the presence, in the wheat, of sharply pointed bits of iron and steel wire which are liable to strike fire when they reach the buhrs, and thereby to cause an explosion and a fire, or if they do not do this they become flattened out and like tiny knives or saws cut themselves through the thin and expensive bolting silk used in covering the reels. To get rid of this nuisance the magnet was called into play.

n the passage of the grain through spouts in which the poles of U-shaped magnets project, the iron and steel particles cling to the magnets and may be removed at intervals.

Magnets are best put in spouts where currents of air work through the wheat.

* No general rule can be laid down as to where the cleaning machinery should be placed. This must be determined for each particular mill, according to the special conditions there existing.

Curiously enough it has been found that the wire binder is not responsible for all the iron that the wheat contains, for the magnets are found to remove an assortment of particles of iron and steel quite enough to constitute a young junk-shop.* Among these may be mentioned rivets, fragments of iron, tacks and nails, bits of elevator cups, particles of iron ore, &c.

The next thing in a well-regulated mill should be the grain meter—a device which not only weighs the amount of grain used by the mill, but measures its flow. By this the miller may know on any one day or at any one hour just how many bushels of wheat it is then taking to make a barrel of flour, so that if he see on Monday that he is making a barrel from four bushels and thirty pounds of wheat, and on Friday that four bushels and fifty pounds are being used, he may search for where the waste is and rectify it.

I told you that one of the principal troubles with which the miller had to contend was the extreme brittleness of the bran, which is more difficult to handle in some varieties of wheat than in others, and at some seasons than at others.

To toughen this bran is desirable; to make the grinding and bolting even the year through he employs, if he is using millstones, a heater, the passage through which immediately precedes the entrance of the wheat into the eye of the millstone.

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* Of course the magnets will not take out brass or copper wire, though some millers expect them to. These do not strike fire, but they cause trouble by cutting the bolting silks.

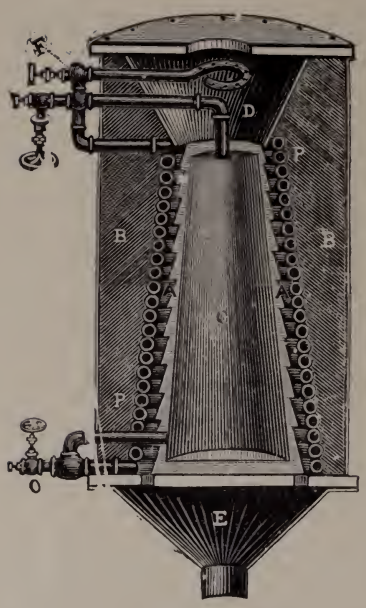

FIG. 8.—SECTION OF WELCH WHEAT HEATER.

In this heater the stream of wheat passes between steam heated metallic surfaces. The heat draws the moisture from the interior of the berry and effects the toughening of the bran. The wheat heater enables the miller to get a uniform grade of flour the whole year around. Hard, flinty, and dry wheat especially need heating, as their bran is always brittle. The skin is tough only so long as hot.

In the Western and Southern States it was at one time recently customary to bring live steam in contact with the wheat, but this operation should be condemned, as there is more than sufficient moisture in the berry itself to accomplish the desired toughening.

Heating is not so necessary where rolls are employed in granulating, as where buhr-stones are used ; in fact,

one trouble sometimes experienced is in the use of heaters for gradual roller reduction. It is that after the first break, and especially after the second break, it becomes pulverized even worse than if heaters were not used. But for buhr milling, to meet modern demands, it is now an absolute necessity.

The next operation is grinding or granulation. In the buhr mill (or "stone" mill,) there are employed either upper runner stones, that is those in which the upper stone revolves, and the lower is the "bed" or stationary stone, or under runner mills, in which the upper stone is fixed and the under one rotates.

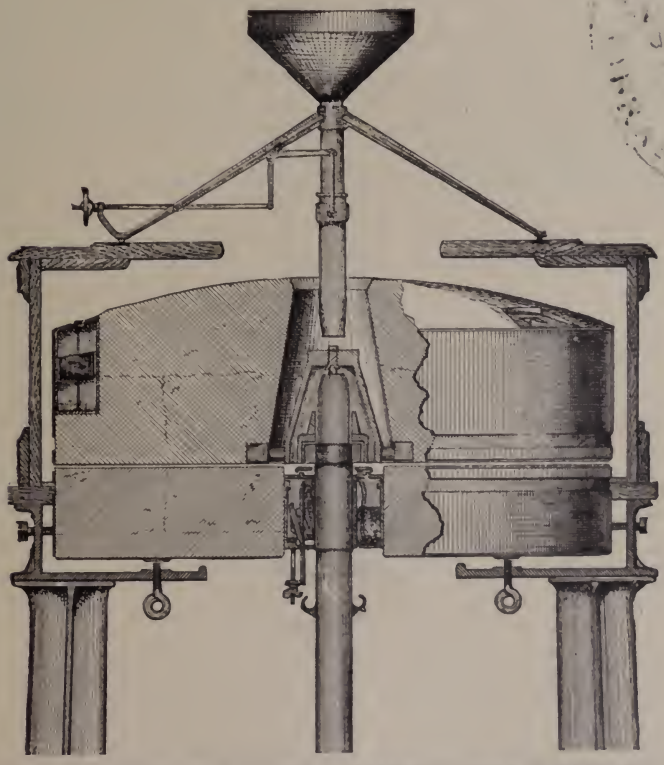

FIG. 9.—SECTION OF NORDYKE & MARMON'S UPPER RUNNER MILL.

Vertical stones are generally for portable mills.

In my remarks I say nothing of grinding any other material than wheat (of course including in wheat milling the grinding of middlings and the cleaning of bran).

Usually, when the upper stone is the runner, it oscillates upon a point on the top of the vertical spindle which drives it.

The connection between the two is loose, so as to allow the stone to oscillate and adapt itself somewhat to any lack of horizontality of the bed-stone or any inclination or eccentricity of the spindle.

One of the most improved drivers for transmitting motions from the rotating spindle to the bail or iron support is so constructed as to allow a large amount of oscillation and adaptation of the runner, without undue vibration, tremor, or fitfulness of running.

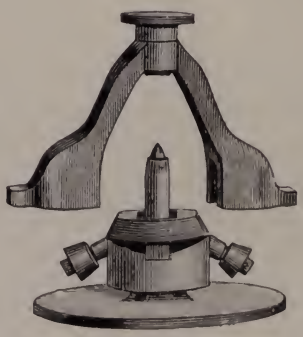

FIG. 10.—SERGEANT DRIVER.

The oscillating upper runner is the oldest known.

In the upper runner the pressure, and hence the fineness of grinding to a certain extent, are given by

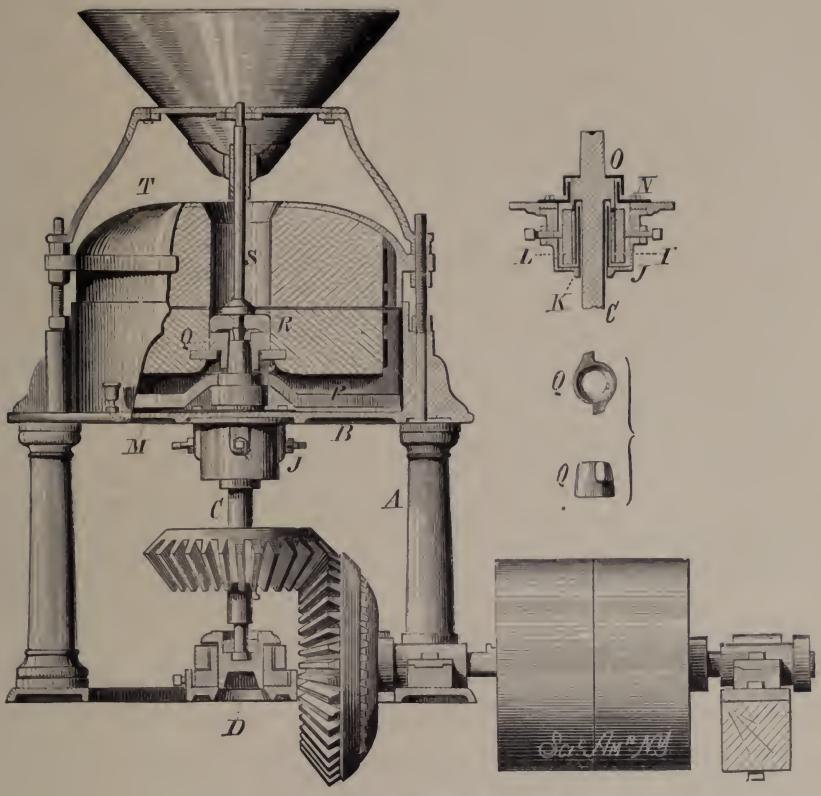

FIG. 11.—MUNSON'S UNDER RUNNER MILL.

the weight of the runner; usually fifteen hundred to two thousand pounds.

In the under runner the fineness of grinding is governed solely by the distance between the buhrs, which is regulated by a screw.

Under runners can be driven faster than upper; they can use a smaller eye, and hence grind nearer the centre; and they choke less.

An upper runner is easier to take up and down than an under runner; when down it is easier to adjust than an under runner; and when in motion it adjusts itself

better to foreign bodies. When grinding there is less pressure on the step than with the under runner; the bush is less intricate and more durable; but the under runner has the greater capacity of the two.

As regards the question of stiff or oscillating connection, it is very easy for any miller who has two run of buhrs to try the two side by side on the same work, and see which is the better.

The changes which have taken place in buhr millstones employed in modern milling are, first in the material of their composition.

This hard, porous, silicious stone comes from a certain district in France, from the long opened and long famous quarries of *La Ferté-sous-Jouarre.* The best of these are rapidly becoming exhausted from the drain upon them from all quarters of the civilized world, so that the old stock is becoming scarcer and higher priced, and is being replaced by closer and harder "new stock" from the new quarries, not so good for wheat.

The clear white and sometimes variegated stone, resembling marble, is among the best for all uses, being free and hard, and holding an edge well; the yellowish is by most millers considered the worst, and has a tendency to glaze.

Cream light and drab are among the best.

A good millstone is told by its even grit, even texture, even openings, and even color; and best of all by its close resemblance to one solid piece of stone with the joints hardly distinguishable. The blocks should

be joined the entire depth, and not simply with a face joint.*

No matter what material be chosen, the stone should be built up of blocks of equal weight and porosity throughout, and as far as possible of blocks of the same size in the same part of the stone. In the runner the block should be of the same size or thickness.

The size of the millstones is being decreased. Whereas in the olden times stones of four and a half and even five feet in diameter were used, now four feet is the largest size employed, and three and a half feet is very usual in certain granulations.†

We find under runners gradually replacing the upper, especially for grinding middlings.

New process buhr milling properly requires as many run of stone on middlings as on wheat.

The "dress" of the stone, that is the mode of laying out and making the furrows, and grinding surfaces, has changed.

Whereas the furrows used to constitute about one-third the area of the stone, and the "lands" or level spaces between them the other two-thirds; now it is the rule to put in as much furrow and as little land as possible, the proportion being now nearly two-thirds furrows to one-third land.

Whereas the granulated surfaces were once carefully cracked or finely grooved by a skillful dresser with

* There are very few mill furnishers able and honest enough to make and supply such buhrs.

† Middlings stones are used as small as two and one-half feet; and many portable mills have vertical buhrs this small.

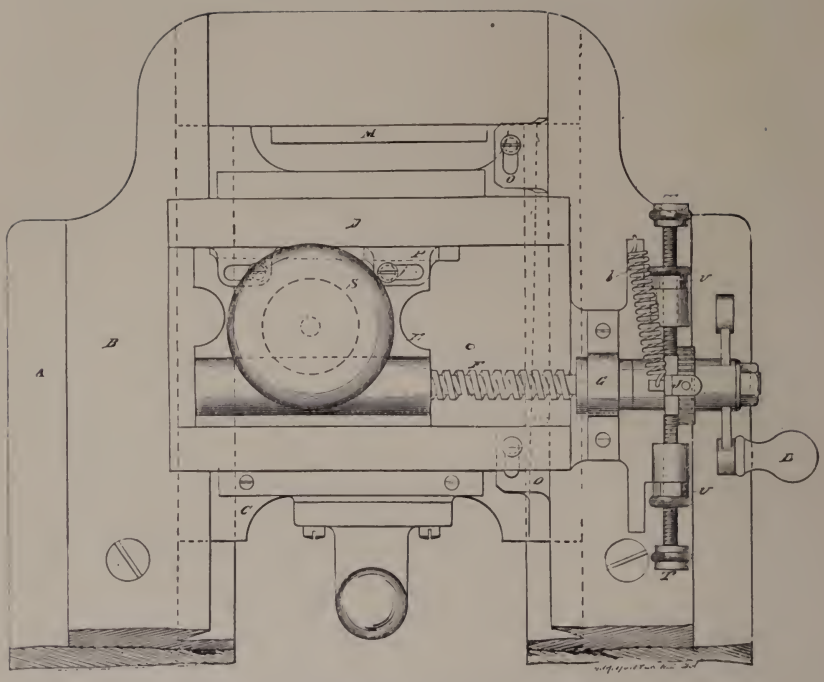

FIG. 12.—GRISCOM DIAMOND DRESSER.

a pick; now smooth surfaces are more in vogue, as tending to tear the bran less.

The dress of the millstone is a subject on which no two millers seem to coincide, except where they agree that each variety of material, each kind of milling, and each kind of stone require a particular dress. A dress that will suit 140 revolutions will not suit 175. There are over two hundred different kinds of dress in use, each having its advocates.*

But no matter what quality of face, what amount of bosom, what draft or section of furrows be employed, the work must be perfect of its kind.

*A special paper on Millstone Dressing, by the author, is in preparation.

Whereas a heavy pick of finely tempered steel, handled by an expert workman, was formerly exclusively used in the tedious operations of reducing the grinding surface to a perfect plane, and making the furrows accurate in depth, width, slope, and surface—now the diamond dressing machine, which is really a planing machine with a diamond tool, is largely used to effect the same operation in at least one-fifth of the time.

A rotating emery wheel is also less generally employed. The makers of emery wheel millstone dressers claim for their machines a smoother furrow and face, and a more distinct and sharp feather edge than by other modes of dress, thus making a free passa e between the stones and through the furrows.

They claim that this adds to the quality of the flour and to the capacity of the stones thus dressed, and requires less wheat to make a barrel of flour.

It is also claimed that the bran is less cut and pulverized, that there is less bran with the flour and less flour with the bran.

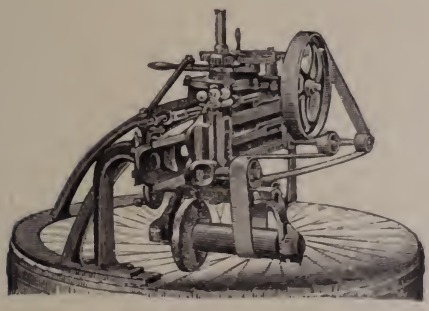

FIG. 13.—COPLIN EMERY WHEEL DRESSER.

FIG. 14.—DEAL'S CORUNDUM POLISHER.

As regards the questions of economy of labor, what two men would do in a week with picks one man with the dresser would do in two or three days, thus saving three or four days' work of the stones to the owner of the mill and eight days' wages.

These two classes of machines exist in great variety, and are rapidly coming into favor and use.

By them, less skilled mechanics may effect better work than was formerly done by the expert, and in one-fifth the time; beside which, the buhr is not idle so long.

Blocks of emery or corundum are also used to sharpen the face and furrows.

The driver was formerly a clumsy, expensive cast-iron affair, with plenty of lost motion; now it is scientifically designed, and reinforced by steel wearing points and with mathematical accuracy.

The mode of feeding the buhr-stone was formerly by means of a shaking shoe and damsel, making what was then considered cheerful music, but which is now conceded to have been an awful row. Now a quiet, adjustable "silent feed" pours its steady stream into the eye of the stone.

Formerly there was trouble from the heating of the millstones, which caused killing or deadening of the flour, also from accumulation of moisture in the spouting, which caused clogging of the bolting silk, and dampness and sourness throughout the spouts. There was also great danger from fire and explosion caused by the extremely fine dust, which, mixed with air in

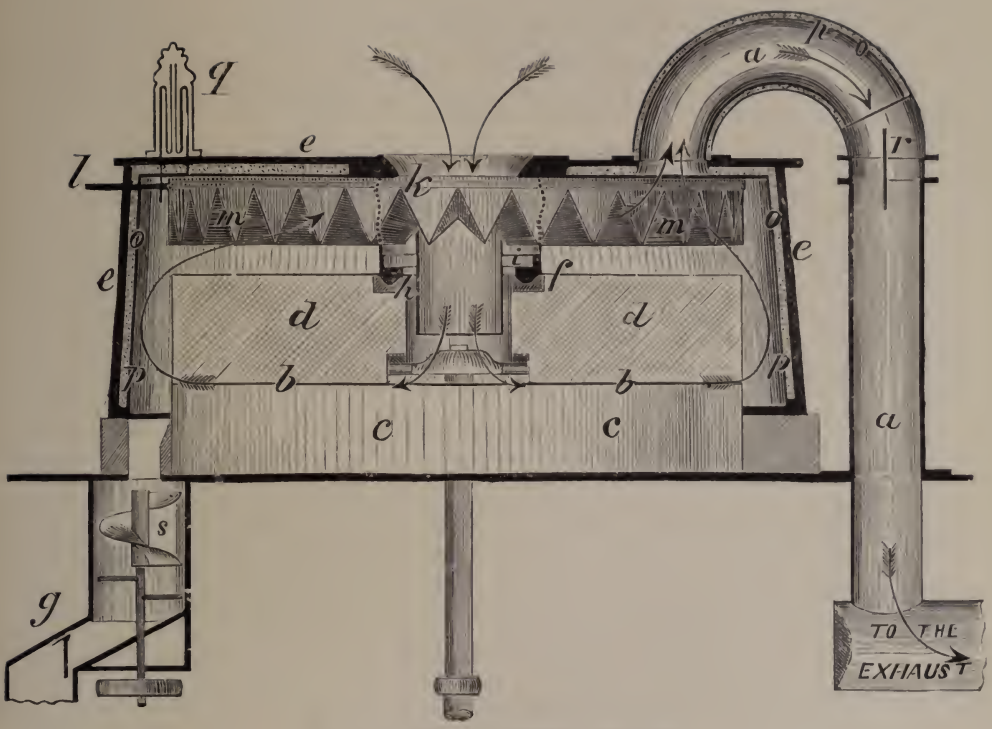

FIG. 15.—BEHRNS-BREHMER EXHAUST.

certain proportions, forms a highly inflammable and explosive mixture, and has wrecked many a mill. The introduction of the wire binder increases the risk in mills having no magnets.

Now this is obviated by the millstone exhaust which I show you, by means of which a current of air is drawn with the feed through the eye of the stone, and keeps the chop or ground product cool and dry, the bolts free, and the passages sweet and devoid of putrefying matter; besides which it saves a certain amount of somewhat valuable material.

The heating of the chop by frictional contact with the millstones is in some mills cured by means of a chop cooler.

Now let us see what the problem is in buhr middlings milling, and how to solve it.

In olden times the chop which issued from the mill-stone consisted (we will suppose well-cleaned wheat to be used), first, of a large percentage of flour, among which there were particles of bran; second, of middlings or imperfectly ground bits of berry, mostly consisting of the portion richest in gluten, lying next the bran. To these middlings, particles of bran and flour adhered. The third material was bran, to which particles of flour adhered.

The aim of the miller was to make as much and as white flour, as large and as clean bran, and as few middlings, as possible, because these middlings, although the most valuable portions of the berry, were of little use to him except as feed, by reason of his inability to remove from them the particles of bran.

Now-a-days the miller has had solved for him the difficulty of purifying the middlings from the particles of bran adhering to and mixed among them.

Since the middlings purifier (which we shall consider in detail further on) has been introduced, the aim of the miller is to make as many middlings as possible, to make them as sharp and granular as he can, to separate the other products from them, and to grind them separately; under which treatment they yield the celebrated "patent flour," the whitest and the strongest that can be made.

I have arranged upon the table here, a complete line of specimens of material from the stone mill of

Welsh Brothers, at Thirty-first and Market streets. (When I say "stone mill," I mean a mill employing buhr stones for granulation.)

To my left you will note a pile of the uncleaned wheat, and to the right of it two piles, one consisting of the same wheat after it has been subjected to the civilizing influences of the separator, the smutter, and the brush, the other being an extremely unattractive mass, consisting of dirt of various kinds, for which the considerate farmer allowed the enterprising miller to pay a cent and a half a pound, there being very likely about a pound and a half of it to the bushel.

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I shall merely remark that if you want dirty wheat, California will do.

With this mass we will have little further to do.

To the right of the cleaned wheat you will notice a pile which is the product of the granulation of the second wheat. It is the "chop" sometimes called "Graham."

It is not a homogeneous mass, but contains, as I have said before, flour, fine bran specks, middlings, and bran flakes, of various sizes, from one side of which I can scrape, beat, or brush a certain quantity of flour.

To the right of this pile of chop I have three piles made by separating these materials, and consisting of undusted bran, unpurified middlings, and unbolted flour.

The next problem of the miller is to get the flour

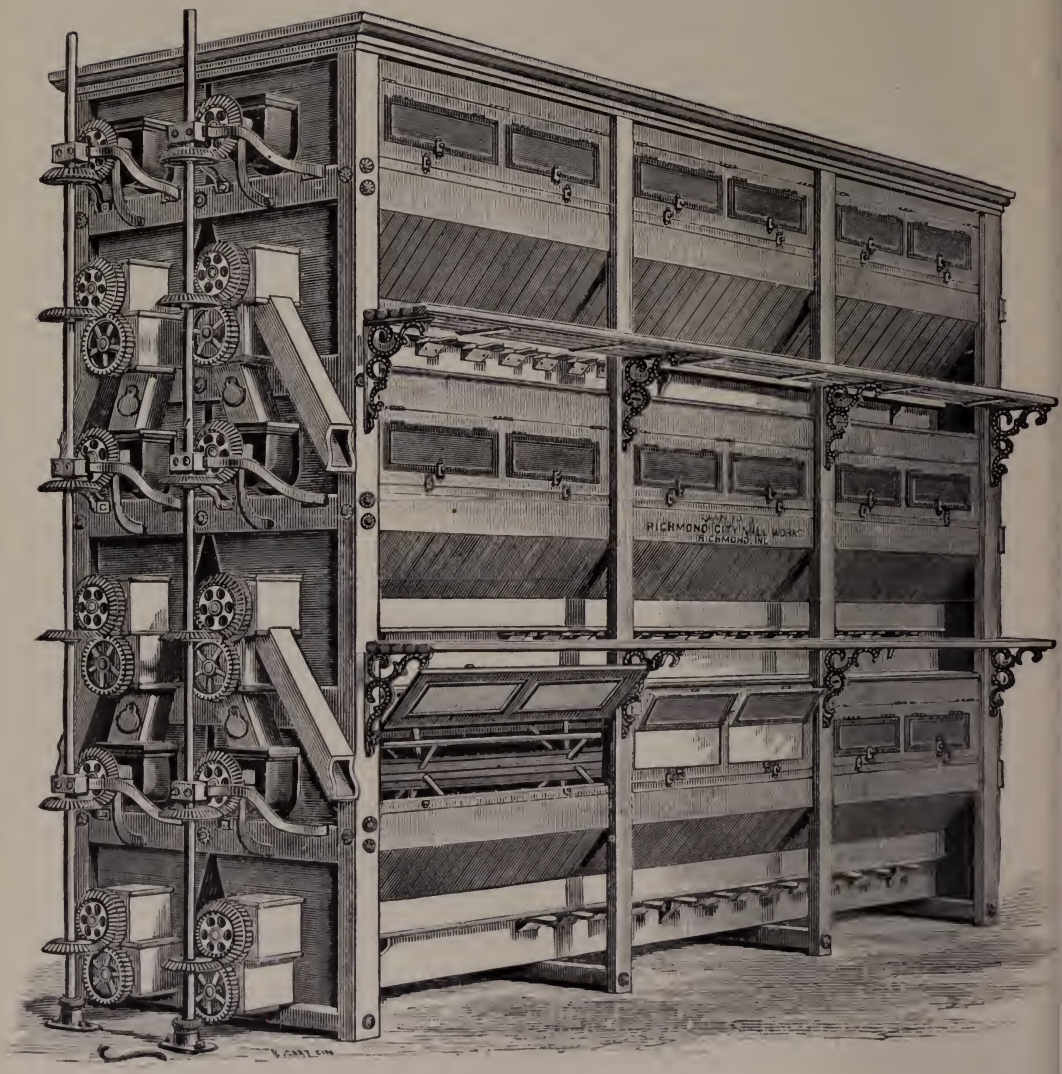

FIG. 16.—RICHMOND CITY BOLTING CHEST.

and the bran separately from the middlings, and to get the bran specks out of the flour. The latter task he generally accomplishes by means of a rotating reel, almost horizontal, covered with fine silk cloth, the meshes of which vary in size from the head to the foot of the reel.

I show you one of the most improved bolting chests, in which the reels and the screw conveyors rotate; also a section of one on a new principle, the bolting silk being on a stationary screen, and the chop being thrown against it.

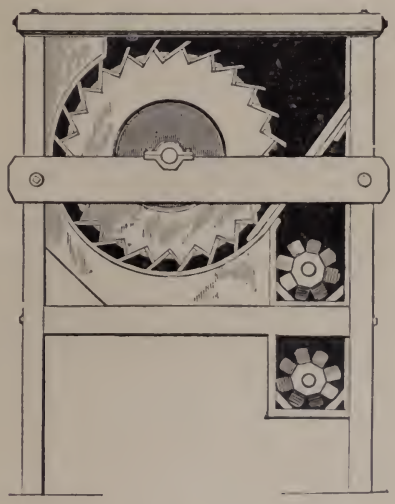

FIG. 17.—SECTION OF SHUTTLEWORTH CHEST.

Throughout the meshes of the silk covering of the rotating reel the flour passes, the finest at one end and the coarsest at the other.

No. 15 bolting cloth, now in common use, contains

21,904 meshes to the English square inch; No. 20 (not often used) contains 29,929.*

Of course a certain amount of bran specks pass through the coarsest meshes. Bran, besides darkening the floor, produces fermentation, making sugar and gum in the bread, hence giving it a dark color.

What tails over is in this case of very little value, because we have supposed the large bran flakes to have been scalped out before. A bird in eating a grain of wheat always rejects the bran.

To get the flour off the bran scales, they must be handled tenderly, because, if beaten or brushed thoroughly, the edges of the particles will chip off and discolor the bran flour.

This bran flour may be removed, first, by passing the uncleaned bran between millstones and then bolting; second, by whipping or beating machines such as are employed for breaking up quartz ores; third, by large brushing machines of which I now show one on the screen, and which are somewhat similar to those employed for effecting the final cleaning of the bran.

The middlings are generally "dusted" or "disintegrated" to remove the particles of adhering flour. They then pass through a machine called a purifier, which has done more to revolutionize milling than has any other class of machines in the mill.

In the middlings purifier there are employed two modes of separation—sieving and air-flotation.†

* There are few articles in which sophistication is so common as bolting silk. None but leading brands should be purchased, and these only of well-known and reliable houses.

† Frictional electricity is now being tried as a means of middlings purification.

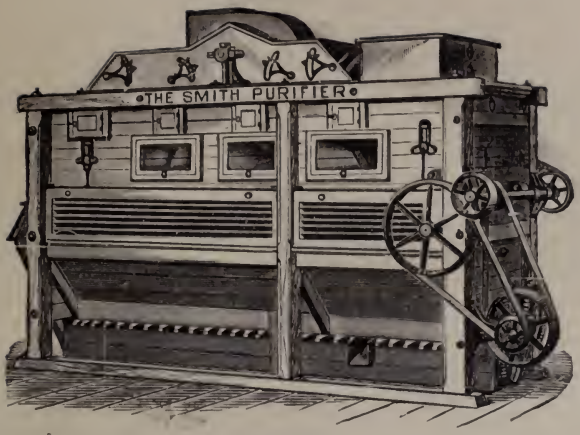

FIG. 18.

This reddish mass of unpurified middlings contains particles which differ in size, in shape, and in specific gravity. They are fed down a slightly inclined lengthwise shaking screen, covered with bolting silk of varying coarseness, the finest at the head.

Through this screen comes from below a current of air adjustable in quantity, direction, and velocity which passes through the thin even layer of middlings lying upon and traveling down the screen, and lifts and floats off the offal or fine bran dust.

The fine middlings pass through the fine meshes at the head, while the coarse purified middlings pass through those at the foot.

Some material tails over to be re-handled, and the offal goes into the stive room.

If the middlings purifier be well adapted to the work, the fine offal will contain very little fine flour, but will be perfectly valueless except for feed.

In the purifier every provision is made to grade the

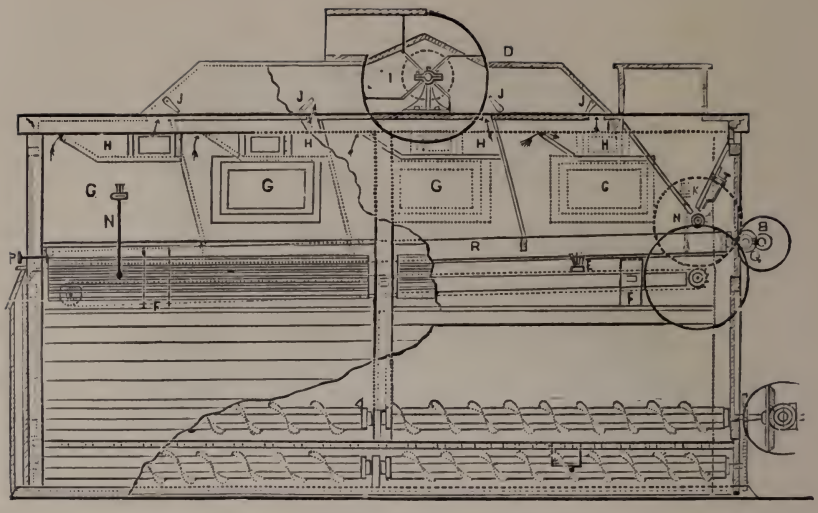

FIG. 19.—SECTION OF SMITH PURIFIER.

currents of air to suit the materials handled, the aim of the miller being to produce middlings which are as hard and granular, and as little flaky as possible.

Middlings require careful handling to avoid breaking them up. The miller must adapt the silk cloth and air current of the purifier to the material which he is handling. Often purifiers are given uneven middlings to work on, and then blamed for poor work.

Other things being equal, hard spring wheat and "new process" milling make larger and sharper middlings than soft winter wheat and "old process," and require a closer cloth and stronger air current in the purifier.

Brownish middlings are heavier than white ones.

The fibre in middlings is often so fine as to be made brown only by the red shade.

Soft returns from rolls, tailings, and finished middlings are hard to purify.

The changes in the bolts rendered necessary by the modern systems of milling are more silk surface and finer meshes, reels of less length and diameter, and an entire difference, which I can not explain in a mere general outline, in the operations of the entire mounting and arrangement of the reels and in the systems of bolting.

The American and Hungarian millers use more silk bolting surface than the English.

The spiral conveyors below the reels carry the material outward and along. By means of suitable cut-off slides, the miller can spout off separately the material that passes through any portion of the length of reel.

There is this thing that can be said in favor of buhrstones:—Nine out of ten that have been working during the last twenty years have been badly hung, ignorantly dressed, and wrongly run, and notwithstanding this, they have done nearly all the flouring in the world. If this device, so improperly cared for and handled, is capable of doing so much and so good work as the stone has done, much better can be done in the future when people better understand it, and with increased demand for it, increases its range and capacity.

The millstone must be given not only a perfect standing balance, but a perfect running balance, so that no portion of it shall tend to tip.

The spindle must be well made and accurately set, and the bush or followers in which its upper end runs must be adjustable to suit any inclination or eccentricity.

To secure perfectly steady, even motion, and freedom from the evils of backlash, which are caused by irregularity in gears, slipping of belts, and by the uneven action of the crank when steam is used as a motive power, it is best to have an "anti-backlash spring" upon the spindle.

It is impossible to do sharp, cool, clean, and even grinding unless the stone be in perfect face. To produce a geometrically accurate face in a practical and simple manner by an instrument that is easily handled and applied, and will neither require truing nor permit of bad work being done with it, I have devised an improved triangular iron paint staff, which has the simplicity of the ordinary red staff, the strength and accuracy of the circular iron device, and the ease of application of the wooden circle staff. It proves three narrow beds, as the miller always does with his straight red-stick; but there is no possibility of these beds being out of plane with one another. It reaches every inch of the burr face, always applying the inexorable "triangular proofs."*

* This device (price sixty dollars, boxed and delivered on cars or boat) is made at the Newton Machine Tool Works, 2341 Callowhill Street, Philadelphia.

HIGH ROLLER MILLING.*

I shall next speak of high roller milling; that is, middlings milling in which rollers are exclusively or largely used for all the various purposes of granulation, middlings grinding, and bran dusting.

The essential features of the so-called Hungarian system are:—

First.—A thorough separation, scouring, and brushing.

Second.—The passage of the wheat between five pairs of differentially speeded rolls, having corrugations increasing in number from about eight per inch of circumference to about thirty.

Third.—Separation of the bran from these breaks by aspiration.

Fourth.—The grading and purifying of the middlings.

Fifth.—The sizing of the large middlings between equally speeded chilled rolls, which also flatten the germ.

Sixth.—Reduction of the purified middlings by differentially speeded biscuit rolls.

Seventh.—Bolting the products of the above operations.

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* This was the title of the second address, in which the general remarks of the first evening were recapitulated for the benefit of those who were not present the week before.

It is claimed that the system is effected with twenty-five per cent. less power, gives twenty pounds extra yield per barrel, and raises the grade of all the flour made.

As I said before, the materials used in the construction of rolls are chilled iron and steel, homogeneous porous cast iron and steel, biscuit (miscalled porcelain), and stone.

The chilled iron or steel rollers (generally chilled iron), are made either plain or grooved; and the grooves may be straight (that is, parallel with the axis of the rollers), or rifled, that is, having a twist which prevents those of one roll catching in those of another *

The grooved rolls are for the cracking, granulating and bran dressing; the plain rolls are for reducing middlings of various sizes down to uniform size.

These chilled iron rolls should be of faultless material and surface, and so hard that a file will not scratch them.

The biscuit rolls are of a gritty porous porcelain, and very hard. They are in length about seventeen inches by nine in diameter. They make 250 revolutions per minute, and with a six inch belt, giving three-horse power at that speed, they will grind into flour 320 pounds of middlings per hour.

I use, and insist upon, the word biscuit, because porcelain is properly biscuit ware which has been glazed, and biscuit is unglazed porcelain.

---

* Soft wheats require more twist in the grooves than hard.

These biscuit rolls are very hard. They are not affected by chemical actions. Being gritty, they do not cake the middlings that pass between them; and they feed easier than metallic rolls.

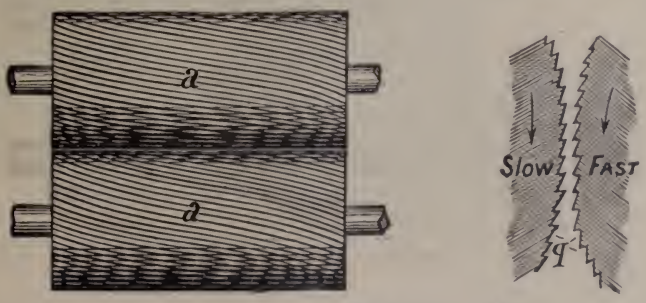
Stone rolls are either furrowed with longitudinal grooves, or plain, according to the uses for which they are intended.

The rolls with spiral corrugations are from twenty-four to thirty inches in length and nine in diameter; they have from eight to thirty corrugations per inch, the larger corrugations being for the first or coarser break.

The sections of these corrugations vary very largely.

Sometimes they are of the outline of a rip-saw tooth, sometimes like those of the Franklin Institute screw thread, that is, a V with the top and bottom cut off: sometimes a gentle wave, sometimes deep waves, and sometimes rounded ribs with flat spaces between them.*

Generally these rolls work in pairs one against another, and they may have rotation either in the same direction or in different directions, and either with an equal speed or with differential speeds.



FIGS. 20, 21.—GROOVED ROLLS. (Allis.)

* The softer the wheat, the more need of roundness in the ribs.

When they have differential speeds, the fast roll has its corrugations or teeth pointing downwards, as you will see by Fig. 21; and makes, say, two and a half rotations to one of the slow roll, in which the teeth point upwards.

The pressure between these rolls should be light.

For a mill of one hundred and fifty to one hundred and seventy-five barrels capacity per twenty-four hours, there are required five to six grooved rolls and two to three smooth ones.*

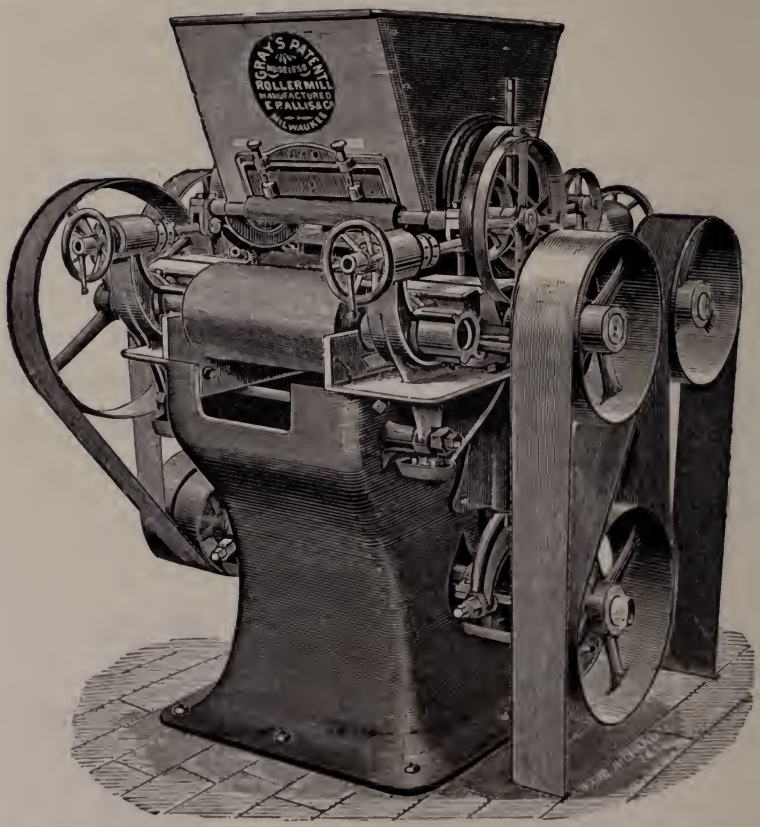


FIG. 22.—GRAY ROLLER FRAME. (E. P. Allis & Co., Milwaukee, Wis.)

* Soft and mixed wheats take more breaks than unmixed hard.

The different materials which are fed to the corrugated rolls are whole wheat, cracked wheat, and bran.*

The smooth metal rolls get large middlings, which are to be sized and degermed; that is, the various bits

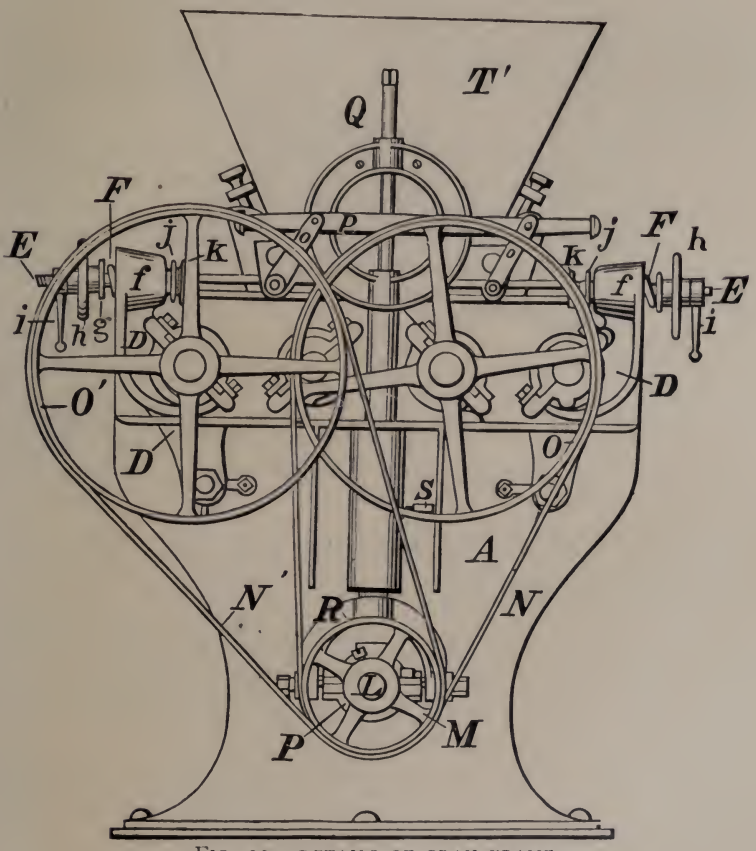


FIG. 23.—DETAILS OF GRAY FRAME.

of berry are to be brought to a uniformly small size, and the germs which are mixed with them flattened, so that they can be bolted out easily.

The porcelain rolls are used for grinding the sized and degermed middlings into patent flour.

* In altering a stone mill to the roller system, gradually, the bran rolls are generally the first put in.

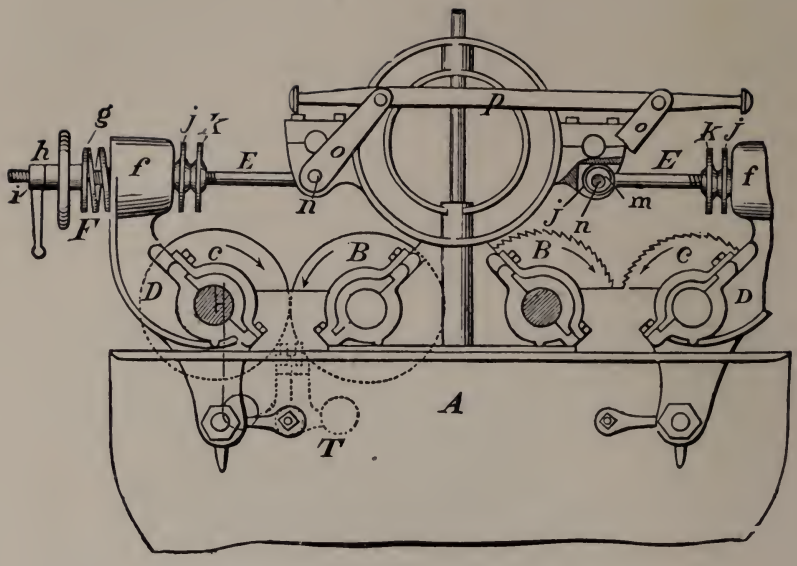


FIG. 24.—DETAILS OF GRAY FRAME.

Figs. 22, 23, and 24 show the most generally used construction of the roll frames.

And now having run over the construction of the rolls, I shall come back to the subject of gradual reduction by means of rollers.

On the table on the left you see arranged a complete series of all the products and materials in the new process buhr mills.

You will note that the piles of the material diverge constantly; it is an expanding series.

On the right I have arranged an equally complete line of materials from a new roller mill recently started in Buffalo,* and you will note that for a large distance

* By courtesy of Messrs. John T. Noye & Sons, Buffalo.

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there is a continuous line which on closer inspection is found to consist of broken particles of the wheat berry, to which the bran still adheres.

At first you will notice the uncleaned wheat, next the cleaned wheat and the dust, which is thrown away; next, what is termed the first break, that is the result of passing the whole wheat from a pair of rolls having eight corrugations to the inch.

The result of this first break is to split the berry lengthwise, and otherwise break it into large pieces, liberating the germ and the crease dirt, and making a small portion of flour of not very high grade.

The cracking yield this first germ, dirty flour, and inferior semolina or middlings.

This first break is passed through a little scalping reel from which the large pieces go to the second break, in which the rolls have ten corrugations to the inch, and are set a little closer.

The same operation is repeated until five breaks have been accomplished, and as the result from scalping the product of the fifth break, you have the bran which then passes to the bran rolls.

Observe then that in this gradual reduction system, there is made at each break only a very small portion of flour and a certain amount of middlings.

The aim is to make as little break flour, as many as sharp middlings, and as large, clean, light bran as possible.

How well this task has been accomplished any miller,

in fact any one of this audience can judge by inspection of the piles of samples.*

The quantity of break flour made in the five breaks is about twenty-five per cent. in most mills; in this mill we are assured that it does not exceed fifteen per cent.

In the proper breaking lies the whole secret of successful milling by gradual reduction.

The number, section, amount of twist, and distance apart of the grooves, are all the object of careful investigation, study, and experiment.

Each variety of wheat should be milled by itself. Theoretically, each variety requires or should have a certain section and twist.

It would be better if possible that berries of a size should be broken together. Large berries make the best flour. American wheat is drier than foreign.

The "Theiss" wheat from Hungary is probably the best for the miller. "Clawson" and "Fultz" are varieties yielding well for the farmer, but abhorred by the miller and baker, as they are starchy and difficult to handle, and make poor flour, unless specially milled by most careful treatment.†

When it comes to bran cleaning it must be remembered that bran is not tough, it requires very careful handling, and for such ponderous machines, weighing as they do three thousand two hundred pounds, to

* Some of the bran flakes were so well cleaned that it was not easy to tell which was the outer side.

† The author will be glad to communicate with those wishing to know how to get flour of good yield, strength, and color, from Clawson, Fultz, or similar starchy wheats.

handle such tender andbrittle material so lightly, and clean it so effectively, speaks high for the patience, ingenuity, and skill of the inventors who devise, and the mill furnishers who construct these machines.

The middlings which are made should be as round, sharp, and granular as possible, and not flaky. The softer and flakier they are, the more difficult they are to purify.

Those from winter wheat are for this reason more difficult to handle than those from hard spring.

Before going to the purifier the middlings should be dusted to remove from any adhering flour, and if the mill is at all a large one they should be graded into at least three sizes, each of which should be treated separately.

The Hungarians, who make from six to thirteen grades of flour in one mill, make from ten to twenty grades of middlings and handle each separately, which unduly complicates the system. As our market does not demand, and in fact would not take so many grades of flour, it is better that we do not make over two or three grades of middlings.

The advantages claimed for the Hungarian system of gradual reduction roller milling, are that it makes broader and cleaner bran; that in granulation there being only a line of contact instead of a large area, the grinding is cool, hence the flour is livelier; that there are more, rounder, and sharper middlings and little germ flour; that the rollers require comparatively little care; that they have less individuality and trickiness (a fault which seems inseparable from the use of

buhr-stones); that they are easy to mount, to drive, to start, and to regulate; that they have positive motion; that the system permits more frequent reductions with the same plant; that the bearings run cool; that there is less damage to the rolls, if any, from light feed; that they are easy to feed; that the accuracy of the grinding surface is easily and definitely proved; that they take less power to make a given amount of flour; that rollers consume only eight to ten horse power per barrel of flour per hour, while buhr-stones will average at least ten to twelve, and even fifteen.

The consumption of fuel in a good roller mill depends, of course, upon the boiler, which develops and the engine which utilizes the steam, as well as upon the character of the fuel itself; but it may be stated broadly that the amount of coal consumed is from twenty-five to forty pounds per barrel of flour.*

It is claimed that the differential motion of the rolls gives one-third more output for the same power than where they have the same speed and motion.

The disadvantages of rollers are that you can not change the dress in a day to suit the character of any new material which you may wish to grind; that they must be dressed at a distance by special machinery instead of in the mill by your own men; and that the system is as yet not applicable to mills of less capacity than one hundred and twenty-five or perhaps one hundred barrels of flour in twenty-four hours.

* E. P. Allis & Co., claim the minimum coal consumption; 22.4 lbs. of coal per barrel of flour. This is in a large mill, using a Reynolds-Corliss automatic cut-off engine, condensing.

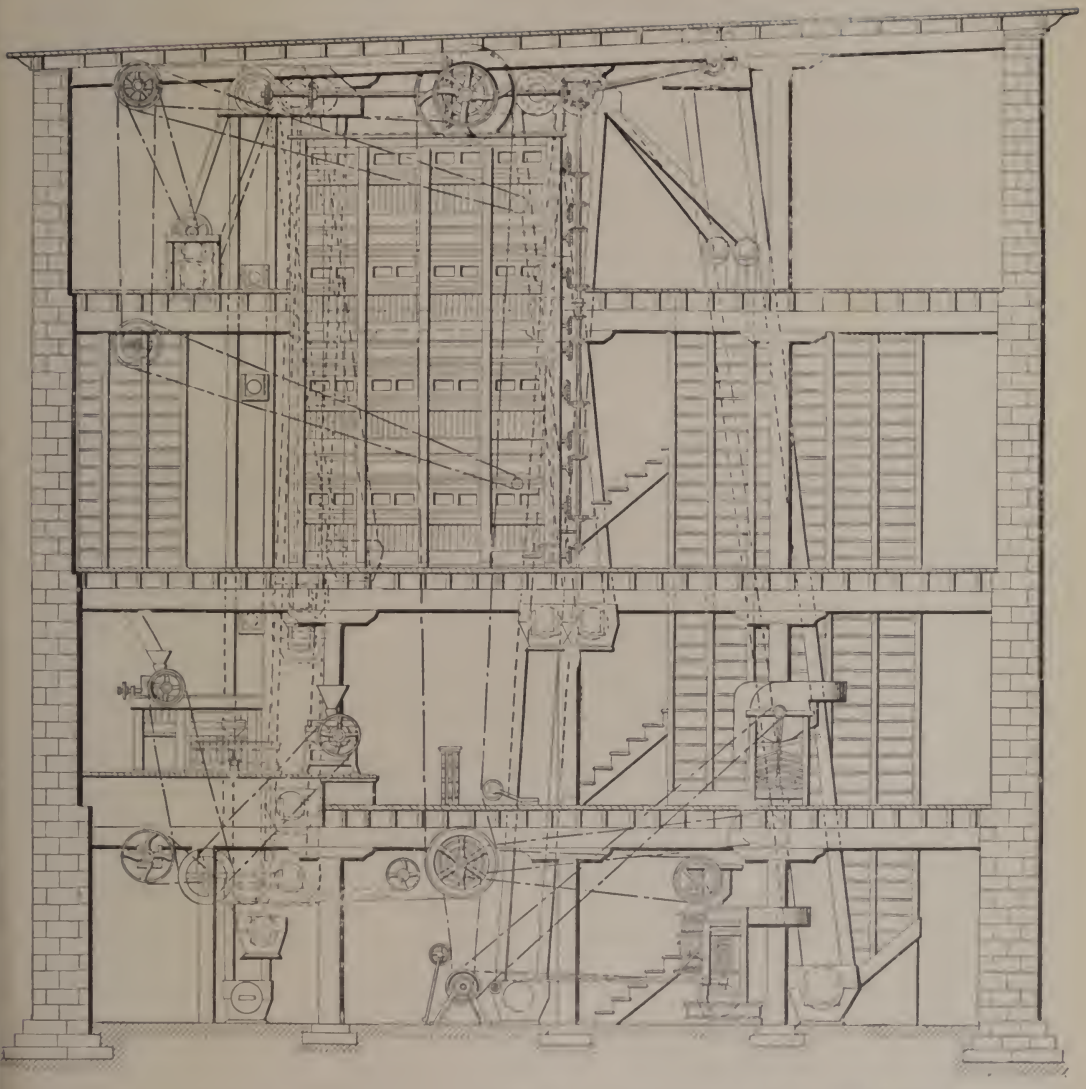
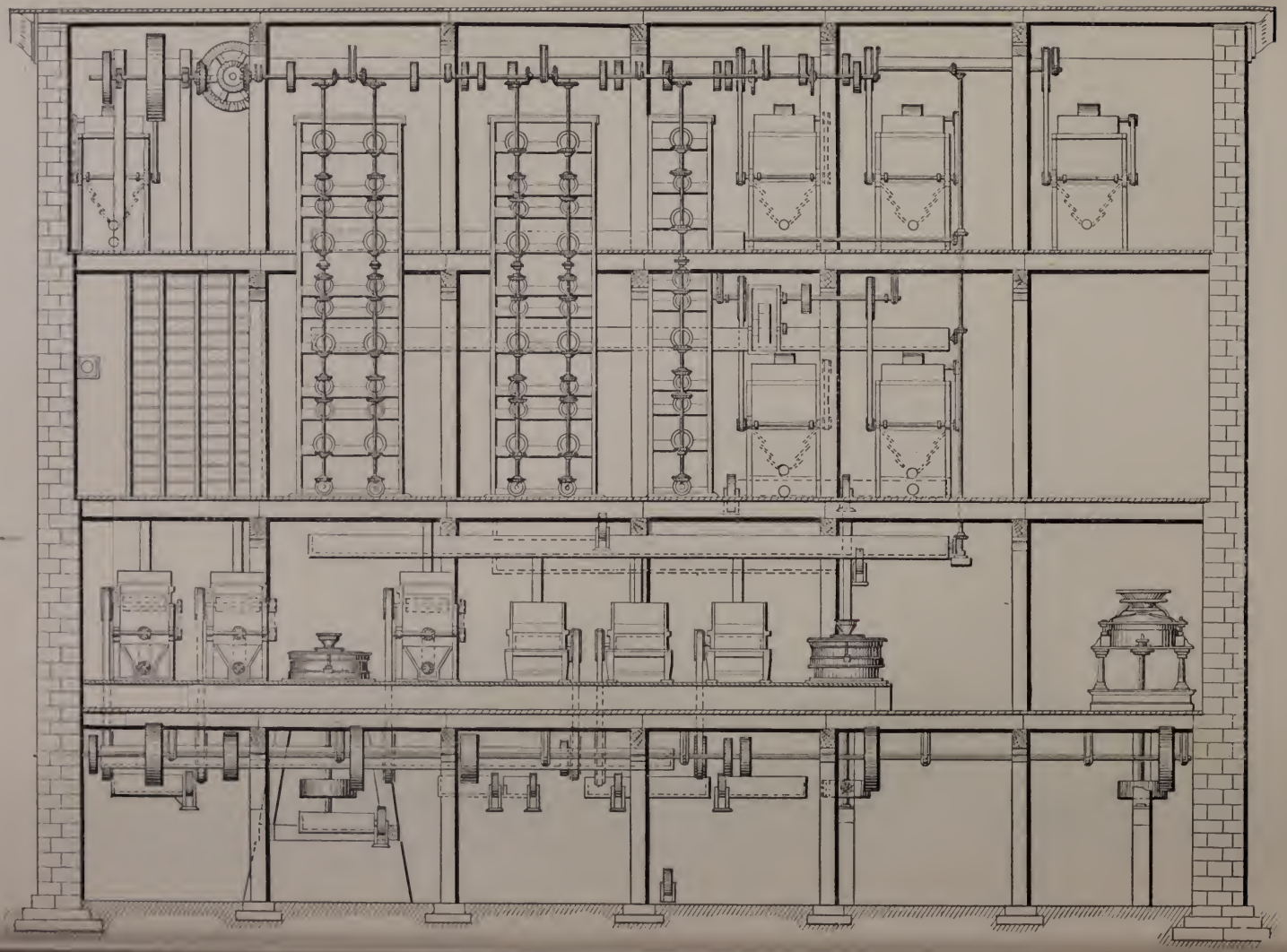


FIG. 25.—DESERONTO MILLS, CANADA. (Designed and equipped by J. T. Noye & Sons, Buffalo.)



Figs. 25 and 26 show two sections of an approved mill of modern construction, recently erected in Canada to run largely with the Stevens round-groove rollers.

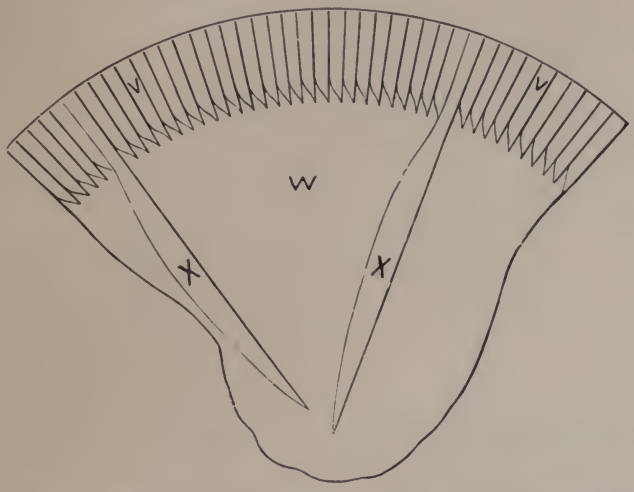


FIG. 27.—PART VIEW OF JONATHAN MILLS' GRADUAL REDUCTION DISK.

In Fig. 27 is shown the dress of the Jonathan Mills' iron gradual reduction disks. They are made by

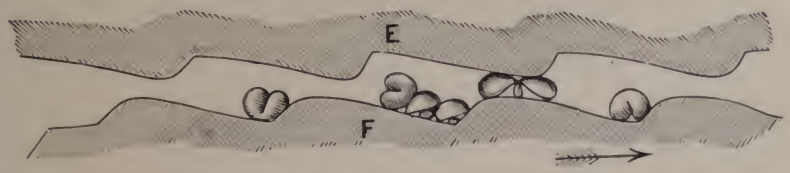
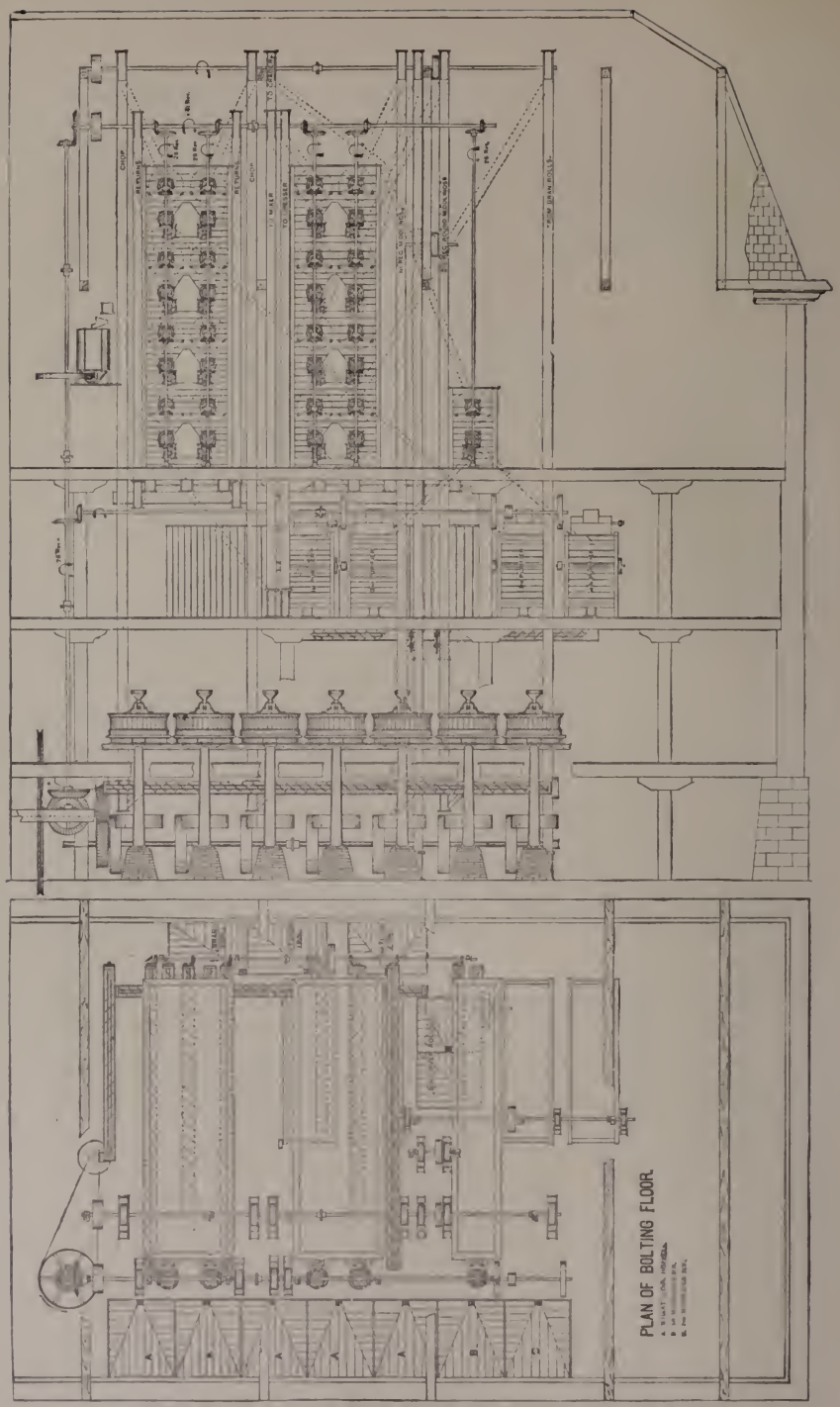


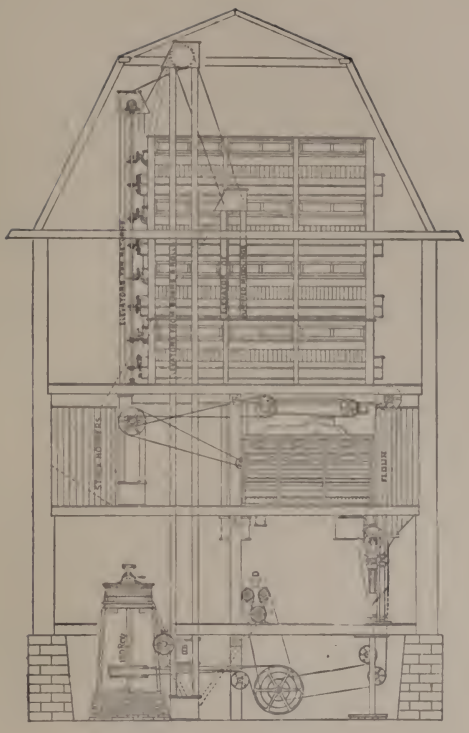
FIG. 28.—SECTION OF JONATHAN MILLS' GRADUAL REDUCTION DISKS, SHOWING IDEAL SPLITTING OF BERRY.

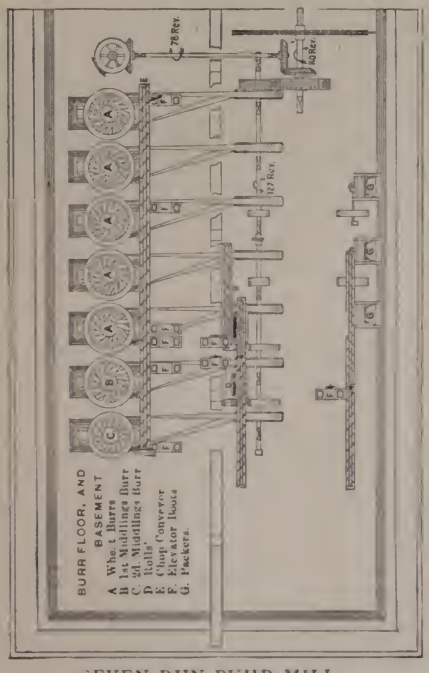
Chisholm Bros., Chicago. Fig. 28 shows in section their action. I hope to have occasion, in the near future, to address you in detail upon the practical workings of the Mills gradual reduction system, which is attracting much attention in our great West.



SEVEN RUN MILL OF THE RICHMOND CITY MILL WORKS.

The illustrations given herewith show a New Process stone-mill especially designed to make the entire product a straight grade of a high quality. There are five run of buhrs for wheat, and two for middlings; four purifiers, one bran duster, two flour packers, one bran packer, one pair of bran rolls, one pair of middlings rolls, thirteen elevators, sixteen reels arranged in two eight-reel chests, and one separate reel for grading. The wheat goes from the stock bins to the five wheat stones. The product of the five runs is equally divided between the two upper reels in the upper chest, there being one elevator for each. These upper reels are clothed to take a part of the flour off at the head, and all middlings off at the tail The middlings which come from the tail of the two upper reels are dusted in the lower reels, and then pass through the grader to the several purifiers. After purification, the middlings go to the two runs of middlings stones, and are then bolted separately on five reels of the other eight-reel chest, arranged precisely like those in the first chest. Two reels in the same chest are used for the products from the rolls, and all flour is finished on the remaining reel, and thoroughly mixed before going to the packers; or, if desired, that portion of the flour made from the middlings is packed separately as a patent brand.





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ABSTRACT OF OFFICIAL REPORT

Read by Mr. Nicholas Elles, Chairman of Committee on Mill Machinery, before the National Millers' Association at the Convention held at Grand Pacific Hotel, in Chicago, June 7th, 1881.

* * * **"Hafner's Springs and Pulleys.**—This simple and yet very effective device for prevention of backlash, &c., is a matter about which I have had many letters from parties using the Hafner's Equilibrium Driving Pulley with Spring Attachment, and all certify that it is a good and valuable device, preventing all strain on spindles, and overcoming the backlash so common in the use of cog or belt gearing. To those millers who are troubled with backlash in their gearing, I would advise a trial of these devices and will say that they will be pleased with it, and a relief will certainly be found by its use. * * * *

"NICHOLAS ELLES,
"*Chairman.*"

Equilibrium Driving Pulley for Mill Spindles.

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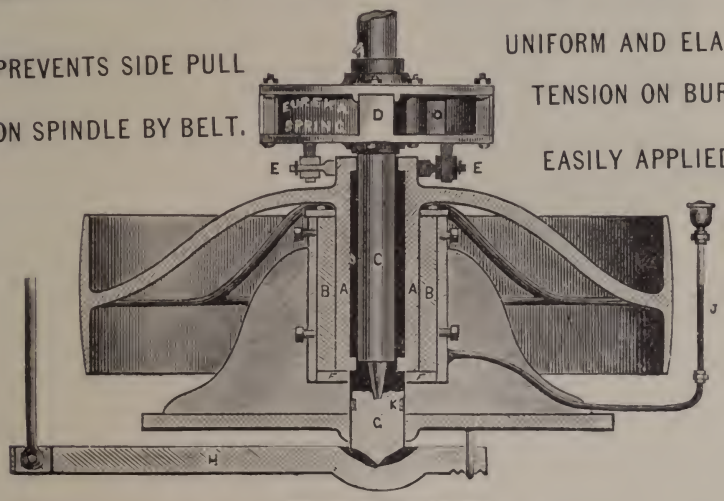
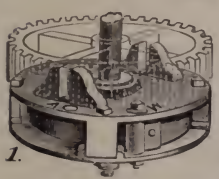
UNIFORM AND ELASTIC TENSION ON BURR.

EASILY APPLIED.



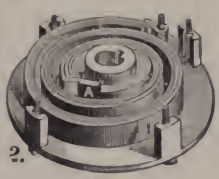
Eureka Coil Spring for Mill Spindles.

Can be applied above or below Pinion.



1.

This is the Spring of which D. R. Sparks, President Illinois Millers' Association, says: "WE ARE ONLY SORRY THAT WE DID NOT GET THEM AT FIRST."



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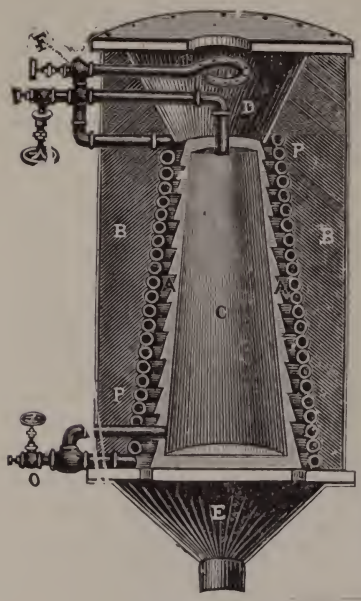

DESCRIPTION OF HEATER.

PP.—Conical coil of pipe.
C.—Hollow iron cone.
AA.—Channel between coil and cone.
BB.—Filled with asbestos.
F.—Steam valve. Can be used at pleasure.
O.—Waste steam.

The wheat enters this machine through one opening, passes down the channel marked AA between the conical coil PP and the iron cone C (notched), spreading out and passing through a series of openings in the bottom, is there caught in hopper E and led to the buhrs, the bran being thoroughly toughened ON EVERY GRAIN.

By the conical shape of the pipe and chamber, every grain of wheat must come in contact with both the coil and cone, and thereby be evenly and thoroughly heated; the notches in the cone cause the wheat to turn over and over as it passes down. This machine, being packed between the coil and jacket with asbestos, prevents radiation of heat.

DIMENSIONS OF HEATER.

Inlet Valve,	½ inch.
Exhaust Valve,	⅜ "
Length of Heater,	21 inches.
" Funnel,	5 "
Entire Length,	26½ "
Opening at Bottom,	3 "

ADVANTAGES OF WELCH'S WHEAT HEATER.

First.—Its peculiar construction insures the even heating of every grain of wheat.

Second.—Being packed between coil and jacket with asbestos, no heat escapes, but is concentrated on the wheat.

Third.—It uses the least possible amount of steam, as no heat is lost.

Fourth.—The outside of the Heater is comparatively cool.

Fifth.—It will both **STEAM** and **HEAT** wheat.

Sixth.—The flour is whiter, and yield greater. The Middlings purer and whiter, and the Bran broader.

Seventh.—It is built on scientific principles.

Eighth.—The cone being Cast Iron, produces a moist heat—a heat that is far superior for heating wheat to that produced by any other metal.

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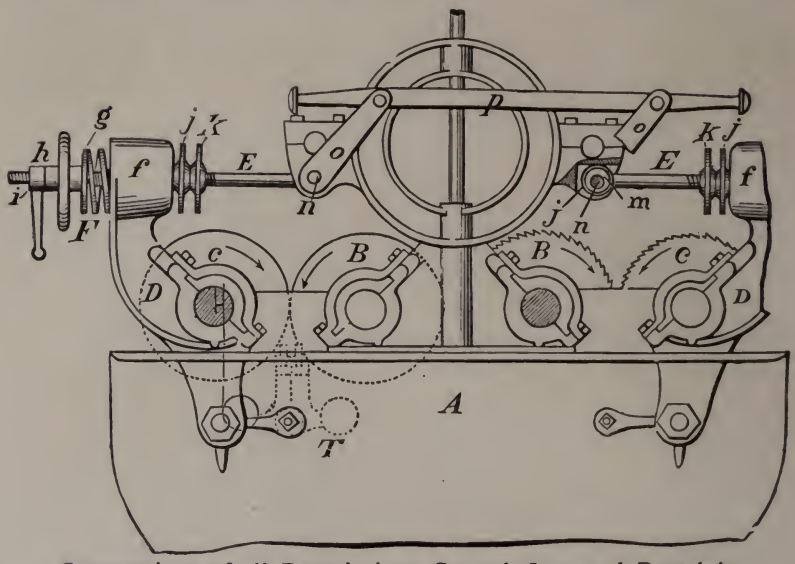

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Important Patented Features of the Gray Roller Mill, and found on no other:

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2d. BELT TIGHTENER.—A rod passes from the top of the Machine to the hangings of the adjustable countershaft on either side. A loosening of the set screw which holds the countershaft hangings, and turning of the tightener rods at the top with an ordinary wrench, sets the countershaft further away, and necessarily tightens the belts.

3d. The journals for the two inside rolls are stationary, while those for the outside rolls are formed on a pivot, swung on an eccentric sleeve, which by turning will either raise or lower the end of the roll, thus enabling the miller to keep one roll parallel with the other, which is absolutely essential to the perfect working of a machine. A new device in the way of a Proofplate we have adopted, which has two parallel edges, and by placing it on two of the rolls at any time will determine whether the rolls are parallel or not. If not, the plate will rock, when by slightly loosening the stay bolt, which holds the eccentric firm, the roll may be raised or lowered until parallel, at which time the plate will remain stationary.

4th. The outside bearing being formed on a pivot, a pull rod runs through it at the upper arm, with a screw on the end for a handwheel, a coil spring around the rod which is seated in the arm casing, a double check nut next the casing, and an eccentric at the other end of the pull rod where it connects with a cross rod. By turning the handwheel you adjust the rolls; the spring will give in case any hard substance should pass through, and no injury will be sustained; the check nuts lock the rolls so they can never touch and do injury.

5th. The rolls, being once adjusted, require no more attention. The eccentric formed at the connection of the four pull rods and the two cross rods, is operated jointly by a connecting lever from one cross rod to the other; thus enabling the miller to throw his rolls apart when shutting down, or together when starting up, without changing the adjustment.

6th. An inside Gate formed in the hopper for each feed roll, by means of an eccentric to each gate and a connecting rod which runs through the hopper with a lever attached on outside of hopper, so that the feed may be shut off and thrown on at any time without changing the adjustment of the set feed.

7th. The general solidity and construction of the Machine.

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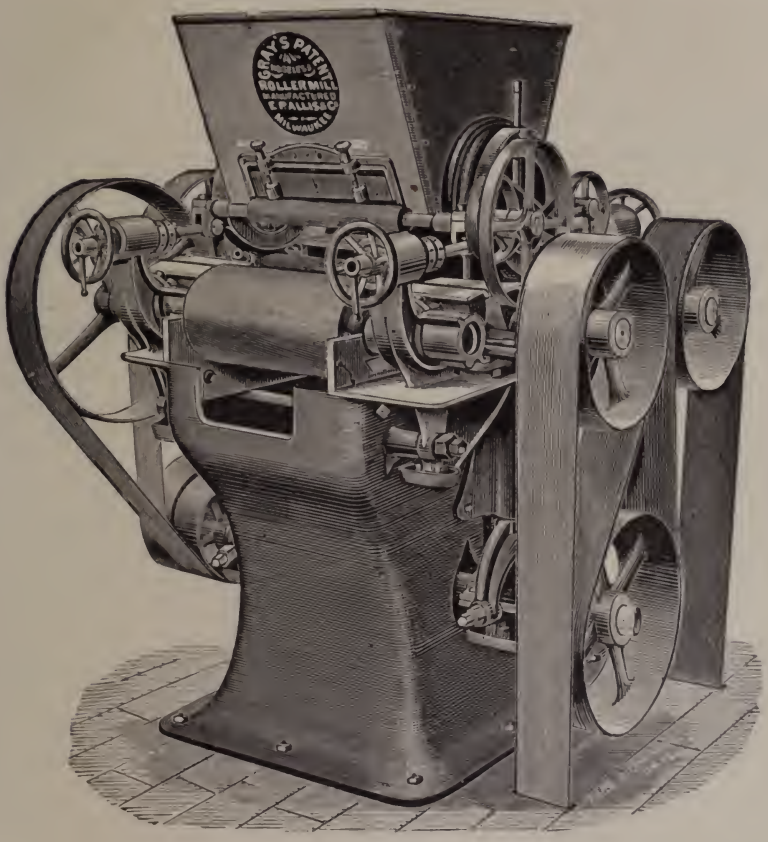

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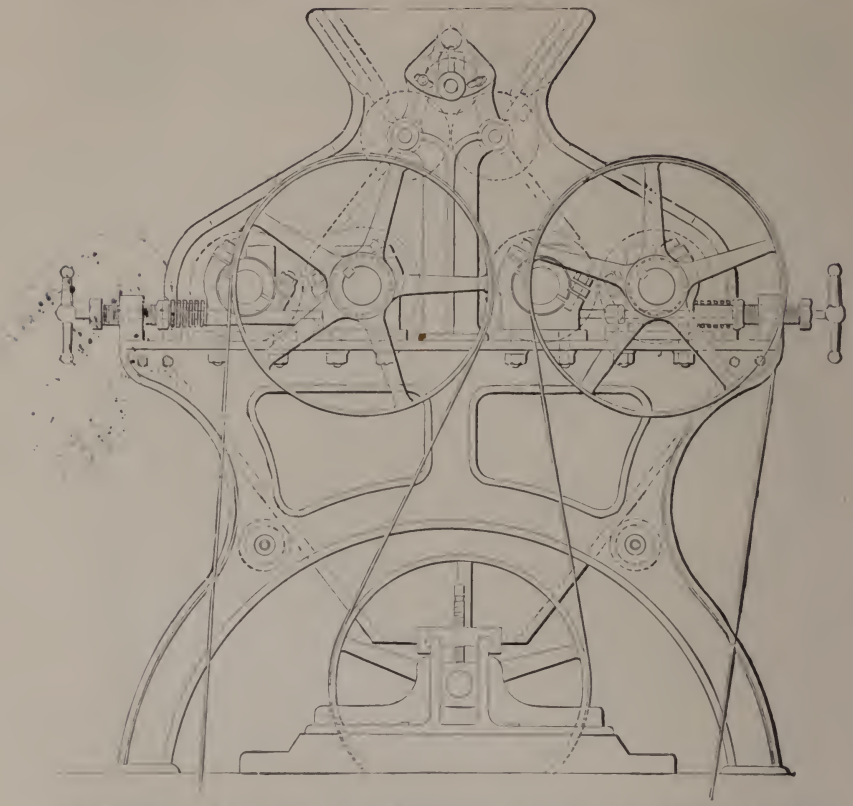

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Third.—The break flour from first reduction contains only germs and dirt which is lodged in the crease of the berry, and the break flour from the remaining breaks is comparatively FREE FROM IMPURITIES.

Fourth.—They make a large quantity of middlings which are free from particles of bran, because the corrugations disintegrate THE BERRY, AND DO NOT CUT IT.

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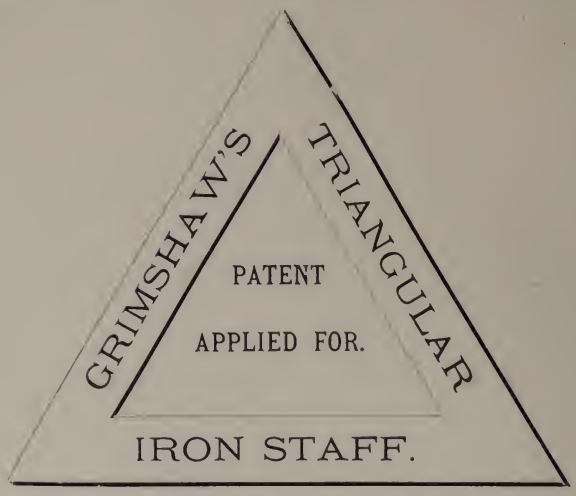

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